Chapter 16

Training STEM Students in LaTeX

Tammy Stitz

Introduction

Graduate students often publish information formally. Science, technology, engineering, and mathematics (STEM) graduate students have a multitude of mathematical equations in their journal articles and conference papers. Entering many equations into a "What you see is what you get" (WYSIWYG) proprietary word processing software, such as Microsoft Word, can be difficult. The Microsoft Word equation editor cannot automatically number the equations and display the number on the same line as the equation. Essentially, the document author must manually enter the equation numbers. To cross-reference the equation, the document author would type each cross-reference manually. It is possible to use the bookmark feature to refer to equations in the text of the document, but bookmarks are lost easily, defeating the purpose of using automation. If another equation is entered in the middle of the document, all of the equations after the new equation in the document must be manually renumbered. Also, equations are not always compatible in different versions of Microsoft Word. For example, this author was creating a thesis in Microsoft Word 2003. When the thesis was updated to the next Microsoft Word version (Word 2007), over 100 equations became images. This was a significant setback because it was necessary to reenter all the equations.

Sometimes LaTeX, a document preparation system based on the TeX typesetting language, is used because LaTeX is unmatched in producing quality typeset equations. The equations are automatically numbered, and it is easy to cross-reference them in the text of the document. In addition, the LaTeX docu-

ment can be generated regardless of which TeX distribution is used. Sullivan and Melvin teach undergraduate students LaTeX in their multivariable calculus class because it produces professional technical documents and equations without much effort.[1] At Sullivan and Melvin's institution, all students majoring in mathematics must use LaTeX for writing assignments in their upper-level courses and in their senior theses.[2]

Open-source software such as LaTeX and the TeX typesetting system have a different objective than commercial software, including word processing software. Most of the time, the developers and other contributors are a group with a common goal and are usually users of the software. As found by Tiwari and Pandey, the internet has greatly improved the quality of open-source software by employing many contributors at various levels worldwide.[3] Synopsys used Coverity Scan to measure the integrity of open-source software.[4] In its report, Synopsys revealed that although commercial and open-source software are improving over time, open-source software has a lower defect density than commercial software.

Some journals, particularly mathematics and physics, require using LaTeX because it simplifies their publishing process. LaTeX separates the content from the format, eliminating, for the most part, formatting errors by the document author. Publishers can create class, style, and LaTeX document files to format the document perfectly. Logically, this could save the journal or conference editor's time.

Word processing software is not designed to produce complicated technical documents, such as a dissertation. Often, all the formatting requirements to create a thesis or dissertation cannot be achieved using Microsoft Word's automated features. Some format requirements must be entered or edited manually by the document author, which increases the time to create the document and the chance of human error. Minicomputer word processing software producers focused on corporate, professional, and home uses, so Microsoft Word was developed as a low-end word processor initially.[5] Therefore, creating complex technical documents was not part of the foundation of the software. LaTeX is a high-quality typesetting system capable of creating complex technical documents. On the Comprehensive TeX Archive Network (CTAN) alone, there are more than 100 class files for theses and dissertations.[6] If the student knows how to use LaTeX, it is much less compli-cated to use LaTeX than commercial word processing software.

No system or software is perfect, so there are some difficulties with LaTeX. For example, it takes longer to learn how to create documents with LaTeX than with proprietary WYSIWYG software. In certain situations, it can be difficult to get the desired placement of figures. In addition, changing fonts is not as simple as pressing a button. Difficulties aside, the advantages outweigh the disadvantages of LaTeX, particularly when creating complex documents or submitting academic papers to publishers.

The objective of this chapter is to illustrate the importance of this type of training. The rest of the chapter will describe LaTeX and why training should be provided by the library. It will describe the evolution of the workshop series using student feedback and observation and compare the behavior of the students taking the online course to those that attend the in-person sessions. Finally, the difficulties encountered during the workshop series will be discussed.

What Is LaTeX?

LaTeX is a document preparation system created by Leslie Lamport in 1985.[7] It is a macro within the TeX typesetting system that was developed by Donald Knuth in the late seventies.[8] LaTeX allows use of high-level markup, which is easier than using the low-level TeX commands.

Many students state that LaTeX reminds them of HTML because LaTeX is highly structured; however, LaTeX is not related to HTML. To illustrate the concept of structure, headings will be used as an example. In HTML, a heading would be `<h1>Heading</h1>` and in LaTeX, a heading would be `\section{Heading}`. The syntax is completely different, but the idea of structure is the same.

A LaTeX document is a text file with a `.tex` extension (e.g., `file.tex`) that contains LaTeX markup. The typesetting engine uses the specified class file and packages, and it interprets the LaTeX markup to apply formatting to the LaTeX document. When the engine generates the document, there will be many files that LaTeX creates for its use. Since the engine must read some of these files and update them, the engine might need to generate the file more than once. The finished document can be a device independent file (`dvi`) or a portable document format file (`pdf`). Most LaTeX users produce a PDF using the `pdflatex` command. A simple LaTeX document (`simple.tex`) is shown in figure 16.1.

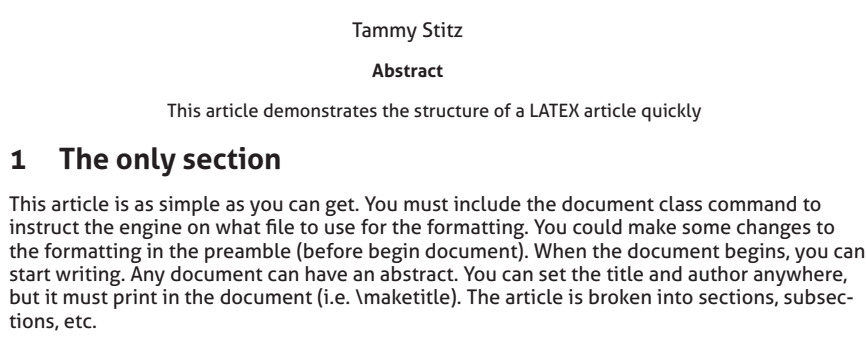
```
\documentclass[11pt]{article}
\usepackage[letterpaper,margin=1in]{geometry}
\title{The shortest article ever}
\author{Tammy Stitz}
\date{}
\begin{document}
\maketitle
\begin{abstract}
This article demonstrates the structure of a LATEX article quickly.
\end{abstract}
\section{The only section}
This article is as simple as you can get. You must include the document class command to instruct the engine on what file to
for the formatting. You could make some changes to the formatting in the preamble (before begin document). When the
document begins, you can start writing. Any document can have an abstract. You can set the title and author anywhere, but
must "print" in the document (i.e. \textbackslash maketitle). The article class is broken into sections, subsections, etc.
\end{document}
```

Figure 16.1
LaTeX article, simple.tex.

When creating a LaTeX document, nearly always, the first command specifies the class file (`.cls`) to use for the document. One of the LaTeX base classes, `article.cls`, is used in the example in figure 16.1. An optional argument of `11pt` is used with the document class to specify an 11 point font. By default, the document would use a 10 point font. The geometry package sets document properties including paper size and margins. The LaTeX markup to generate the document is between `\begin{document}` and `\end{document}`. The markup that occurs prior to `\begin{document}` is called the preamble. Essentially, the preamble is used to set values and provide definitions necessary to format the document. All types of environments will use the `begin` and `end` commands, such as the abstract environment. The `maketitle` command tells the engine to include the front matter: title, author, and date. The font in the generated PDF would vary slightly from what is shown in figure 16.2, but it is close to the actual document.

In figure 16.2, all of the front matter is typeset in the PDF except the date. The date was suppressed because the `date` command was used and the argument was empty (i.e., `{}`). If the `date` command was not listed in the `tex` file, the date the PDF was generated will appear. Sections, subsections, figures, tables, and so on are automatically numbered unless the number is suppressed in the markup. There is nothing in the preamble to change the font, line spacing, paragraph spacing of titles, sections, or normal text, so it is displayed as defined by `article.cls`.

Thesis and dissertation class files are usually based on `book.cls` or `report.cls`. Most publisher-supplied class files for journal articles are based on `article.cls`. Publisher class and style files will likely supply special commands and environments with good documentation. If LaTeX basics are understood, one can understand the documentation and use the publisher-supplied files quickly.



The shortest article ever

Tammy Stitz

Abstract

This article demonstrates the structure of a LATEX article quickly

1 The only section

This article is as simple as you can get. You must include the document class command to instruct the engine on what file to use for the formatting. You could make some changes to the formatting in the preamble (before begin document). When the document begins, you can start writing. Any document can have an abstract. You can set the title and author anywhere, but it must print in the document (i.e. \maketitle). The article is broken into sections, subsections, etc.

Figure 16.2

PDF generated from `simple.tex`.

Why Training Should Be a Library Service

In 2007, the Association of Research Libraries (ARL) surveyed its member libraries, and 43 percent of the eighty responding libraries had publishing services.[9] Hahn stated, "The question is no longer whether libraries should offer publishing services, but what kinds of services libraries will offer."[10] Hahn's report focused on journal publishing services, but it acknowledged that there were various related library services. Park and Shim created four categories of scholarly communication in order to draw a connection between library publishing services and scholarly communication.[11] Park and Shim examined the services at Cornell, Dartmouth, MIT, Columbia, University of Michigan, Duke, University of Calgary, and Simon Fraser University. Content preparation, layout work, and converting content format were included in the vast array of services, and LaTeX training could be classified in any of these services.

In fall 2010, a survey was distributed using the University of Akron's web portal. After three weeks, two hundred affirmative responses were received indicating LaTeX training was needed at the University of Akron (UA). At UA, some courses used LaTeX to prepare documents, but they were very few and could not fulfill the university-wide need for LaTeX training. In addition, there was a LaTeX class file and template for theses and dissertations that was created by a mechanical engineering professor, but one would need LaTeX knowledge prior to using the template. There was LaTeX expertise on campus, but the experts were not a cohesive, collaborative group. Most graduate students did not have a contact for assistance with LaTeX. A library service could be established to train graduate students to use LaTeX and give them a point of contact when they needed help.

LaTeX training fits well into the frame Information Creation as a Process.[12] Authors use LaTeX to format their scholarship that can be shared and disseminated. Since graduate students would not have eight consecutive hours or more to attend the workshop, each topic became a workshop session. In attaining the objectives of these workshop sessions, attendees tend to exhibit the behaviors described in the dispositions of Information Creation as a Process. For example, the first workshop session, Finding, Installing and Using LaTeX Software, enables students to install the appropriate software for their operating system and use it. After the workshop session, students can install the LaTeX packages needed and locate documentation about LaTeX. In fact, each workshop session illustrates that documentation is needed by students and experts alike. An expert user doing something new seeks LaTeX documentation, where LaTeX is the "underlying creation process."[13] In addition when using the software to generate

a document, students are studying the process of creating scholarly information using LaTeX.

Focusing on the workshop series in its entirety, the disposition "accept the ambiguity surrounding the potential value of information creation expressed in emerging formats or modes" applies.[14] When students become aware of the learning curve to use LaTeX, they generally begin questioning the utility of LaTeX. Experience with LaTeX demonstrates its utility, but in the beginning it is a leap of faith. Throughout the series, they realize that content is more important than fonts, text weight and size, and even citation styles due to the formatting being separate from the content. The content, which is the true indicator of quality information, will be entered the same with little variation regardless of the formatting applied by various class files and packages. For example, the content in a `tex` file could be nearly identical for a journal article and a paper uploaded to an institutional repository. Only the class file used and the commands and environments that it provided would differ.

A graduate student could submit a journal article to one publisher. If it was not accepted, the student could use the class file for another publication and the document would need very little editing. The separation of content and formatting helps students "resist the tendency to equate format with the underlying creation process."[15] In looking at image file formats that can be embedded in with LaTeX, students realize that "the creation of information may begin initially through communicating in a range of formats or modes."[16] Users might export an image from software used in their research that is not compatible with LaTeX, so it would require conversion. The students might need to experiment using various image formats to find the best rendering that can be embedded in a LaTeX document.

In developing the workshop series, the sessions are designed with the idea that students should not use LaTeX for everything. They must "understand that different methods of information dissemination with different purposes are available for their use."[17] For example, they would not need to use LaTeX for letters or flyers unless it is better than other tools at their disposal.

Development of the Workshop Series

The workshop series was released as a pilot open to the entire university community. Some faculty and undergraduate students attended the sessions in the six years since the first two workshop sessions were offered; however, a great majority of the attendees were graduate students.

In spring 2011, the pilot workshop series consisted of the first two planned sessions. An additional session was added each semester to complete the series.

Originally, the series was five modules, but it was obvious from student feedback and observation that one ninety-minute workshop was not adequate to cover lists, cross-referencing, footnotes, tables, and figures. Starting spring 2012, the series consisted of seven sessions:

- Finding, Installing and Using LaTeX Software;
- Using Document Classes and Packages for Your Journal—Preamble and Document Structure;
- Writing a LaTeX Article—The Basics;
- Writing a LaTeX Article—Using Tables;
- Writing a LaTeX Article—Embedding Figures;
- Writing Formulas for a LaTeX Article; and
- Using BibTeX.

The objective of the workshop series was to enable students to create a simple LaTeX article after attending the sessions.

Although over 200 survey respondents wanted LaTeX training in the 2010 survey, enrollment was much lower. In addition, several students would enroll and not attend the sessions. To remedy this situation, an email reminder was sent the day before the workshop session, so the students would not forget. Also, to ensure that the interested students were available during the workshop sessions, an electronic availability survey was distributed before the schedule was set. These efforts helped somewhat, but the registration was still lower than expected. Nevertheless, there was a dedicated base of graduate students attending the workshop series. In fact, these graduate students were interested in having more individual workshops than were offered. Some LaTeX experts on and off campus were enlisted to meet this need.

During summer 2013, an online noncredit course option was added to give the students a choice in course format. The course was designed by adhering to the *Quality Matters Rubric Standards 2011–2013 Edition with Assigned Point Values*. For example, the course learning objectives were clearly stated and measurable, and all course material, assignments, quizzes, and so on aligned with the learning objectives.[18] The course contained pre- and post-quizzes and homework. The students could choose between video and textual material to learn the content. The course was designed using other online learning best practices, such as grading with individualized feedback.[19] In addition, virtual help session hours were established to emulate the in-person experiences that students valued. The LaTeX electronic mailing list was created to establish a sense of community. In the same vein, discussion boards and a team assignment existed to encourage student cooperation.[20]

Feedback was collected from the in-person and online students. Continual improvements were made throughout the series, which in turn made the grad-

uate students more engaged.[21] Sometimes only a portion of student suggestions could be implemented, but the graduate students realized their comments were important and respected.

An extremely important and effective change made to the workshop series due to student feedback was the complete overhaul of the second session, Using Document Classes and Packages for Your Journal—Preamble and Document Structure. It was noted that many students dropped out of the series after session two. Initially, it was assumed that the students decided that they could teach themselves. After feedback was collected from the students, it showed that the lack of understanding of the publisher documentation was a barrier. Although the students were instructed step by step how to complete the session and reassured that understanding would occur naturally in future sessions, many of these students judged that LaTeX was too difficult to learn. A study by Men and colleagues determined that the statistical distribution of learning materials accessed by students taking a MOOC followed a Zipf distribution.[22] Zipf believed that individuals estimate the total amount of work that they will encounter in an endeavor and they will take the path that will require the least amount of work on average.[23] This course was not designed as a MOOC, particularly since students could have direct interaction with their instructor; however, the LaTeX online workshop shared the MOOC's noncredit nature. Students encountered module two and assumed that the total amount of work would be more than they could expend on a noncredit course. After the second module was redesigned to introduce document structure using `article.cls` only, post-quiz two indicated that the students did not find the new second module, Using Document Classes and Packages—Preamble and Document Structure, discouraging.

Another important change to the workshop series was to provide details about Mac OS X and varieties of Linux as well as Microsoft Windows. The TeX Live distribution and many LaTeX editors are cross-platform, and several of the graduate students were not using Microsoft Windows. This change impacted the first session the most; however, it had positive unintended effects. Supporting multiple operating systems made troubleshooting more efficient for the students and the instructor. Although much software was cross-platform, there were functional differences depending on the operating system used. For example, the `pdflatex` command will run up to five executable files. These files were considered external files by Microsoft Windows and Linux, although they were from the TeX distribution. Microsoft Windows will grant TeX Live permission to run these files. Linux required additional switches used with the `pdflatex` command.

In spring 2016, the learning materials pertaining to publisher classes were expanded to create another session. Using a publisher class file was a valuable experience for the graduate students. The problem was that it was offered too early.

By offering this session eighth in the series, students could apply all their new skills to generate a document. During the session, students could use any publisher files and content they desired. Skills from workshop session one were applied first. Students downloaded the documentation provided by the publisher for submitting a journal article using LaTeX. Some publishers supplied class files, packages, BibTeX style files, documentation, and so on. Other publishers supplied a template `tex` file and dictated how existing LaTeX commands and environments were used. Students installed the publisher's class file, packages, or any other files supplied by the publisher when necessary. The skills and terminology learned in workshops two through seven enabled the students to understand the documentation.

During the workshop session, the students could use any files supplied by the publisher, including `tex` files that they could use as a template to produce an authentic activity. In addition, no memorization was required because this would not occur in the real world. Therefore, they could use any documentation to complete their task. When a class file was used, students applied commands and environments specified by the class file without much difficulty due to the LaTeX commands and environments they learned in the workshop series. At the end of the session, they had a journal article using a publisher class file. There was no lecture portion of this session. The instructor was available for technical support and questions as they completed their task.

Another additional module was developed during the online series requiring the students to hone their LaTeX skills. Initially, it was designed as a team assignment, but unfortunately most students would not complete this assignment. Feedback from the few that completed it stated that it was too difficult to collaborate since students could complete the modules at their own pace. They felt that the assignment would be more valuable as an individual exercise. Essentially, this module introduced a new class (`book.cls`) and required the students to correct two chapters of a book that were riddled with errors. Troubleshooting skills are essential when using LaTeX, so this module is important. First, the students choose from a list of chapters in a few books in the public domain. The downloaded `zip` file contained three `tex` files, image files, and PDF files of the original chapters. They solved every error, then they posted the corrected files to their assignment folder. Also, they described each error, told how they solved it, and acknowledged any help that they received. All errors were code errors. There were no intentional misspellings or grammar errors.

The publisher class and the troubleshooting workshop sessions allowed the graduate students to reflect upon what they learned in the workshop series. The students became more confident because they could apply their new LaTeX skills fairly easily. The students made connections between all of the sessions taken previously to achieve the series learning objective, to enable students to create a simple LaTeX article.

Differences in Behavior of Students in the Classroom and Those Online

Some students prefer in-person learning, other students prefer, or have time constraints that require, online learning. An online course was designed to reach those students. Twenty-eight graduate students signed up for the online workshop and completed the first module. Half of the students dropped out after module one. As indicated from student feedback, some students dropped out because they felt that the workshop would be too much work after viewing module two. In the same vein, it was speculated that some students did not want homework in a noncredit class. Homework assignments were necessary to represent the in-class activities. LaTeX must be used to learn it. The online help sessions offered using Webex were established for students preferring the individualized help that was provided in-person, but no students took advantage of this service. Some students took advantage of the discussion boards that were established to seek help. Other students were given twenty-four hours to answer the question on the discussion board before the instructor answered the question.

Five students finished all of the online modules, and all indicated on the class survey that they were very satisfied with the workshop's usefulness and the responsiveness and knowledge of the instructor. All but one student was very satisfied with the workshop materials' clarity, and that student was satisfied. In grading the post-quizzes and homework, it was observed that in general, each student improved with each module. With their feedback and quiz results, many module clarity problems were resolved. On average, the students performed very well on their assignments and post-quizzes. From the course feedback, it was determined that the textual material and videos were adequate most of the time.

A direct comparison could not be made between the in-person and the online students because the `tex` file could not be examined as thoroughly during the in-person sessions. Mostly, their `tex` file was viewed when someone needed help. In addition, most in-person graduate students did not take the pre- and post-quizzes that the online students completed. Limitations aside, some characteristics of and comparisons between the in-person and online students can be discussed.

Initially, the in-person LaTeX workshop sessions dedicated the last five minutes of class to completing an online survey. The survey responses gave thoughtful ways to improve the workshop, and the students were, for the most part, satisfied with the series. The online students had fewer suggestions for improvement because the series was altered based on the earlier classes of in-person surveys. Unlike the online students, most students that attended all of the workshop sessions in person contacted the instructor at least one time since the

last workshop session. Most of the time, the graduate students needed help, but some wanted to share new LaTeX information or comment about how the workshops reduced the learning curve when using LaTeX on their own. Most of the time when the graduate students wanted help, they wanted to meet in person to be taught how to fix their issue. There were various possible reasons that the online students did not contact the instructor, such as that the online students did not feel connected to their instructor or that they were independent learners by nature. By observation, most in-person students created what was required in class; however, some students created part of the requirements, and others limited their participation to looking at the `tex` file only. The students who did not drop out of the online workshop completed their homework and post-quizzes entirely. Some in-person students tried to troubleshoot their code before asking the instructor for help. Other in-person students ran the code one time and wanted the instructor to fix it for them. The online graduate students corrected their own code and rarely asked for help.

Difficulties

Marketing of the workshop series was not reaching all of the UA STEM graduate students and proved to be more challenging than expected. Some of the faculty referred their graduate students to the workshop series, and other faculty members did not tell their students. Unfortunately, some of the faculty did not realize the value of LaTeX to their advisees. A direct email to all graduate students was not possible, so administrative assistants or secretaries in individual departments were contacted to send the email. Since marketing has not been uniform among the departments, additional marketing strategies will be investigated.

The noncredit nature of this workshop series made student retention difficult, particularly for the in-person workshop sessions. Sometimes, only one to four people finished the entire series. The graduate students that signed up for the sessions wanted to learn the material. As more of their credit classes had assignments due, they had to prioritize tasks, and noncredit work fell to the bottom of the list. Student retention was better during the summer session because the students had fewer classes. As a result, the LaTeX in-person training will be offered in the summer. In the fall, graduate students can sign up for the online workshop, which will encompass both the fall and spring semesters.

The online students took the quizzes and homework to make the next module available. They had no choice if they wanted to continue. The in-person students never completed the electronic quizzes. In the future, a paper assessment will be handed out during the in-person sessions, which was an effective method in other workshops taught by the author.

Conclusion

LaTeX workshops are a useful addition to library publishing services for graduate students, particularly in the STEM fields. Often, there are LaTeX experts on campus to assist in implementing the service. The workshops will require time; otherwise, the service can be established at no cost. With effective marketing and adequate workshop attendance, a campus-wide community of LaTeX users can be established to support each other in their endeavors. Many former LaTeX workshop attendees declare that the workshop series enables them to use LaTeX more quickly. Establishing LaTeX workshops will save the time of STEM graduate students when they publish journal articles, write their thesis, and create other academic documents.

Notes

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